

Preface

The advanced optimization algorithms may be classified into different groups depending on the criterion being considered such as population based, iterative based, stochastic, deterministic, etc. Depending on the nature of phenomenon simulated by the algorithms, the population-based heuristic algorithms have two important groups: evolutionary algorithms (EA) and swarm intelligence algorithms. Some of the recognized evolutionary algorithms are: genetic algorithms (GA), differential evolution (DE), evolutionary strategy (ES), evolutionary programming (EP), and artificial immune algorithm (AIA). Among all, GA is a widely used algorithm for various applications. GA works on the principle of the Darwinian theory of the survival of the fittest and the theory of evolution of the living beings. DE is similar to GA with specialized crossover and selection operator. ES is based on the hypothesis that during the biological evolution the laws of heredity have been developed for fastest phylogenetic adaptation. ES imitates, in contrast to the GA, the effects of genetic procedures on the phenotype. EP also simulates the phenomenon of natural evolution at phenotype level and AIA works like the immune system of the human being. Some of the well-known swarm intelligence based algorithms are: particle swarm optimization (PSO), which works on the principle of foraging behavior of the swarm of birds, ant colony optimization (ACO) which works on the principle of foraging behavior of the ant for the food, shuffled frog leaping (SFL) algorithm which works on the principle of communication among the frogs, and artificial bee colony (ABC) algorithm which works on the principle of foraging behavior of a honey bee. Besides these evolutionary and swarm intelligence algorithms, there are some other algorithms which work on the principles of different natural phenomena. Some of them are: harmony search (HS) algorithm which works on the principle of music improvisation in a music player, gravitational search Algorithm (GSA) which works on the principle of gravitational force acting between the bodies, biogeography-based optimization (BBO) which works on the principle of immigration and emigration of the species from one place to the other and league championship algorithm (LCA) which mimics the sporting competition in a sport league.

All the above-mentioned algorithms are population-based optimization methods and have some limitations in one or the other aspect. The main limitation of all the algorithms is that different parameters (i.e., algorithm-specific parameters) are required for proper working of these algorithms. Proper tuning of these parameters is essential for the searching of the optimum solution by these algorithms. A change in the algorithm-specific parameters changes the effectiveness of the algorithm. Most commonly used evolutionary optimization algorithm is the genetic algorithm (GA). However, GA provides a near optimal solution for a complex problem having large number of variables and constraints. This is mainly due to the difficulty in determining the optimum controlling parameters such as crossover probability, mutation probability, selection operator, etc. The same is the case with PSO which uses inertia weight and social and cognitive parameters. Similarly, ABC requires optimum controlling parameters of number of bees (employed, scout, and onlookers), limit, etc. HS requires harmony memory consideration rate, pitch adjusting rate, and the number of improvisations. Sometimes, the difficulty in the selection of algorithm-specific parameters increases with modifications and hybridization. Therefore, the efforts must be continued to develop an optimization algorithm which is free from the algorithm-specific parameters.

An optimization algorithm named as “Teaching-Learning-Based Optimization (TLBO)” is presented in this book to obtain global solutions for continuous as well as discrete optimization problems with less computational effort and high consistency. The TLBO algorithm does not require any algorithm-specific parameters. The TLBO algorithm is based on the effect of the influence of a teacher on the output of learners in a class. Here, output is considered in terms of results or grades. The teacher is generally considered as a highly learned person who shares his or her knowledge with the learners. The quality of a teacher affects the outcome of learners. It is obvious that a good teacher trains learners such that they can have better results in terms of their marks or grades. Moreover, learners also learn from interaction among themselves which also helps in their results. The TLBO algorithm is developed with this philosophy. Furthermore, an elitist version of TLBO algorithm (named as ETLBO) and a non-dominated sorting version (named as NSTLBO) for multiobjective optimization are also presented in this book.

The TLBO algorithm is developed by my team and it is gaining wide acceptance in the optimization research community. After its introduction in 2011, the TLBO algorithm is finding a large number of applications in different fields of science and engineering. The major applications, as of April 2015, are found in the fields of electrical engineering, mechanical design, thermal engineering, manufacturing engineering, civil engineering, structural engineering, computer engineering, electronics engineering, physics, chemistry, biotechnology, and economics. Many research papers have been published in various reputed international journals of Elsevier, Springer-Verlag, Taylor & Francis, and IEEE Transactions, in addition to those published in the proceedings of international conferences. The number of research papers is continuously increasing at a faster rate. The algorithm has carved a niche for itself in the field of advanced optimization and many more researchers may find this as a potential optimization algorithm.

This book provides a detailed understanding of the TLBO algorithm and its versions such as elitist TLBO algorithm and non-dominated sorting TLBO algorithm for multiobjective optimization. Also it provides the applications of TLBO algorithm and its versions in different fields of engineering. The computer codes of TLBO and ETLBO algorithm are also included in the book and these will be useful to the readers. The book is expected to be useful to various engineering professionals as it presents the powerful TLBO algorithm to make their tasks easier, logical, efficient, and effective. The book is intended for engineers, practitioners, managers, institutes involved in the optimization related projects, applied research workers, academics and graduate students in mechanical, manufacturing, electrical, computer, civil and structural engineering. As such, this book is expected to become a valuable reference for those wishing to do research by making use of advanced optimization techniques for solving single objective or multiobjective combinatorial design optimization problems.

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While every attempt has been made to ensure that no errors (printing or otherwise) enter the book, the possibility of these creeping into the book is always there. I will be grateful to the readers if these errors are pointed out. Suggestions for further improvement of the book will be thankfully acknowledged.

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